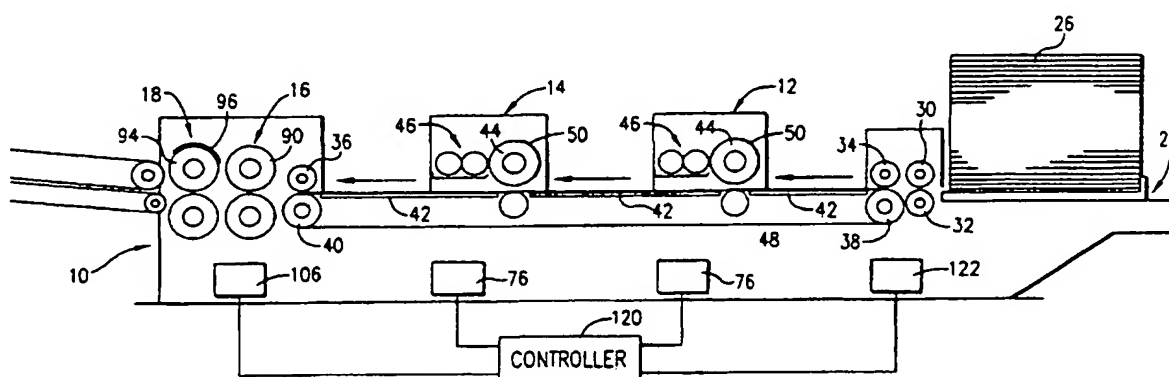




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<b>(21) International Application Number:</b> PCT/US96/15324 <b>(22) International Filing Date:</b> 25 September 1996 (25.09.96) <b>(30) Priority Data:</b> 08/546,789      23 October 1995 (23.10.95)      US <b>(71) Applicant:</b> LAWRENCE PAPER COMPANY [US/US]; 2801 Lakeview Road, Lawrence, KS 66044 (US). <b>(72) Inventors:</b> HILL, Alan, M.; 3669 S.E. Arrowhead Drive, Topeka, KS 66605 (US). MEEKS, William, R.; 2200 Harper D-46, Lawrence, KS 66046 (US). <b>(74) Agent:</b> COLLINS, John, M.; Hovey, Williams, Timmons & Collins, Suite 400, 2405 Grand Boulevard, Kansas City, MO 64108 (US).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** BOX BLANK PRINTER/SLOTTER APPARATUS**(57) Abstract**

A box blank forming apparatus includes at least one printing assembly (12, 14), a slotting assembly (18), and a feeding (24) and conveying (28) mechanism for feeding blanks (26) through the apparatus. The feeding (24) and conveying (28) mechanism brings the blanks (26) into contact with the printing cylinder (44) and the slotter blade (96) to complete printing and slotting operations on the blanks (26) in the formation of boxes. An interrupter (52) is provided in association with the printing assembly (12, 14) for removing the blanks (26) from contact with the printing cylinder (44), and similar structure can also be provided with the slotting assembly (18) for removing the blanks (26) from contact with the slotter blade (96). A controller (120) is provided for controlling operation of the interrupter (52) of the printing assembly (12, 14) and may be used to also actuate the interrupter structure (106) of the slotter wheel assembly (18). This allows the printing assembly (12, 14) and the slotter wheel assembly (18) to accommodate box blanks of variable length.

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BOX BLANK PRINTER/SLOTTER APPARATUS5      Background of the Invention1.      Field of the Invention

10      The present invention relates generally to the art of box blank formation, and more particularly to a box blank forming apparatus having a printing assembly, a slotting assembly, and a controller for selectively interrupting printing and slotting of each blank to regulate the positioning and number of imprints and slots formed in each blank, regardless of the length of the blanks.

2.      Discussion of the Prior Art

15      Conventional box making operations involve initially die cutting a box blank from a sheet of corrugated paper board or other suitable material, followed by creasing and slotting the blank to define the sides and end flaps of the blank. It is also possible to print on the blank by passing it through one or more printing assemblies prior to creasing and slotting.

20      In conventional box blank forming machines, the blanks are fed from a supply stack by a conventional sheet feeder or the like, and are advanced through the printing assemblies and into the creasing and slotting assemblies by a conveyor so that each blank is imprinted and includes a series of spaced slot pairs of desired length separated by continuous creases. Each printing assembly includes a printing cylinder supported for rotation on the frame of the apparatus, an inking assembly for inking the printing cylinder, and an impression cylinder opposing the printing cylinder for bringing blanks into contact with the printing cylinder for printing. The conveyor is perforated, and several vacuum trays underlie the conveyor for permitting a vacuum to be drawn through the conveyor so that blanks are held against the conveyor as they are conveyed between the printing and impression cylinders of each printing assembly and through the apparatus.

30      In order to permit each printing assembly to be independently removed from operation, the impression cylinder of each printing assembly is supported by eccentric hubs that allow shifting of the impression cylinder toward and away from the printing cylinder in a direction generally transverse to the travel path of the blanks through the apparatus. The vacuum

35

trays of the conveyor are also supported by the eccentric hubs so that the conveyor can also be moved toward and away from the printing cylinder. By providing this construction, it is possible to set up the machine for single color printing by removing all but one of the printing assemblies from operation, or to set up any number of printing assemblies for multi-color printing, it being understood that each assembly is used to print a single color on the blanks.

A mechanism is provided for manually turning the eccentric hubs during down time of the apparatus to shift the impression cylinder and conveyor between a printing position adjacent the printing cylinder in which the impression cylinder and conveyor bring blanks into contact with the printing cylinder, and an interrupted position in which the impression cylinder and conveyor are spaced from the printing cylinder by a distance sufficient to allow blanks to be conveyed past the printing cylinder without being printed.

The creasing assembly of a conventional machine includes an upper drive shaft on which a plurality of creasing wheels are supported for rotation. An anvil roller opposes the creasing wheels and defines a nip into which the blanks are conveyed so that a series of longitudinal creases are formed in the blanks as they pass through the assembly. The slotting assembly of a conventional box blank forming machine includes a plurality of slotting wheel mechanisms supported on a drive shaft. A lower anvil roller opposes the slotting wheel mechanism and defines a nip into which the blanks are conveyed as they leave the creasing assembly so that at least one set of laterally spaced slots are formed in each blank as it is conveyed through the slotting assembly.

A problem encountered with conventional printing assemblies and with conventional slotting assemblies is that there are limitations on the size of blanks that may be handled. In particular, since the printing cylinders and slotting wheel mechanisms of conventional machines are of fixed circumference, the maximum box blank length which may be formed using such structure is limited to lengths less than this fixed circumference. It is not possible to produce box blanks of a length greater than the circumference of the printing cylinders and slotting wheel mechanisms of a particular apparatus without fitting the apparatus with larger cylinders and slotting mechanisms. Such modifications to any apparatus are expensive, and result in a significant amount of down time.

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U.S. Patents 5,297,462 and 5,327,804 disclose slotting wheel mechanisms having dynamically retractable slotter blades that allow the formation of boxes of various sizes, including lengths larger than the circumference of the slotting wheel mechanisms. The disclosure of these patents is hereby incorporated into the present application by this express reference. The slotting wheel mechanisms disclosed in the noted patents provide greatly improved box making operations which allow the "skipping" of cutting during one or more successive slotting wheel revolutions. With this configuration, blanks of virtually any size may be readily slotted without stopping the slotting wheel mechanism and without the need for employing larger diameter mechanisms. However, due to the inability of conventional printing assemblies to accommodate similarly oversized blanks, any printer/slotter apparatus incorporating such an improved slotting wheel mechanism would be limited to use with blanks smaller than the circumference of the printing cylinder. Thus, the advantage gained by the improvement in the slotting wheel mechanism would go unrealized in the printer/slotter apparatus due to the restrictions imposed by the printing assembly.

#### Objects and Summary of the Invention

It is an object of the present invention to provide a printing assembly having a means for interrupting printing on the fly during the passage of each blank through the assembly to enable a single impression to be made on each blank as the blanks are conveyed through the assembly, even when the blanks are of a length greater than the circumference of the printing cylinder used in the assembly.

It is another object of the present invention to combine control of both the printing assembly and slotter wheel assembly of a box blank forming apparatus to enable handling of box blanks of various sizes, including sizes greater than the circumferences of the printing cylinders and slotter wheels of the apparatus.

In accordance with these and other objects evident from the following description of a preferred embodiment of the invention, a box blank forming apparatus is provided for forming blanks of variable length. The apparatus includes a printing cylinder having a central longitudinal axis and being supported on the frame of the apparatus for rotation about the longitudinal axis, and a drive means for driving rotation of the printing cylinder. An

impression cylinder is supported on the frame for rotation about an axis parallel to the longitudinal axis of the printing cylinder, and a feeding means is provided for feeding the sheets along a travel path extending between the printing cylinder and the impression cylinder.

5           The apparatus also includes an interrupting means for moving the printing cylinder and impression cylinder toward and away from one another between a printing position in which the impression cylinder and feeding means bring sheets into contact with the printing cylinder and an interrupted position in which the impression cylinder and feeding means are spaced from the  
10       printing cylinder by a distance sufficient to allow sheets to remain out of contact with the printing cylinder. A control means is provided for actuating the interrupting means to move the printing and impression cylinders relative to one another between the printing and interrupted positions during both rotation of the printing cylinder and operation of the feeding means to enable a single  
15       impression to be made on each sheet as the sheets are passed between the cylinders, regardless of the length of the sheets.

          By providing a box forming apparatus in accordance with the present invention, numerous advantages are realized. For example, by controlling the interrupting means to interrupt printing on the fly during the  
20       passage of each blank past the printing cylinder, it is possible to print a single time on each blank as the blanks are conveyed through the assembly, even when the blanks are of a length greater than the circumference of the printing cylinder used in the assembly.

          In addition, by providing a printing assembly having this capability  
25       of handling universally sized blanks, it is possible to combine control of the printing assembly and of a suitable slotting wheel mechanism to permit printing and slotting of such universally sized blanks in a single apparatus. Thus, recent advances made in the design of slotting wheel mechanisms can be used with the present invention to increase the versatility of a box blank forming  
30       apparatus, and both the printing and slotting operations can be controlled to accommodate blanks of various sizes.

#### Brief Description of the Drawing Figures

          The preferred embodiment of the present invention is described  
35       in detail below with reference to the attached drawing figures, wherein:

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Fig. 1 is a schematic side elevational view of a box blank forming apparatus constructed in accordance with the preferred embodiment;

Fig. 2 is a schematic side sectional view of a printing assembly forming a part of the box blank forming apparatus, illustrating the assembly in an interrupted position in which no printing is carried out;

Fig. 3 is a schematic side sectional view of the printing assembly, illustrating the assembly in a printing position;

Fig. 4 is a side elevational view of the printing assembly in the interrupted position;

Fig. 5 is a sectional view taken along line 5-5 of Figure 4;

Fig. 6 is a side sectional view of a slotter wheel assembly forming a part of the box blank forming apparatus;

Fig. 7 is a fragmentary sectional view of the slotter wheel assembly, illustrating a single slotter wheel mechanism of the assembly; and

Fig. 8 is an end elevational view of the slotter wheel assembly.

#### Detailed Description of the Preferred Embodiment

A box blank forming apparatus constructed in accordance with the preferred embodiment is illustrated in Fig. 1, and broadly includes a frame 10, a pair of printing assemblies 12, 14, a scoring assembly 16, and a slotting assembly 18. The frame includes a pair of laterally spaced side walls 20, 22, shown in Fig. 5, that are secured together by suitable means and are supported on the floor of a production facility. The spacing between the side walls establishes the maximum width of box blanks capable of being formed by the apparatus.

Returning to Fig. 1, a conventional blank feeder assembly 24 is supported at one end of the frame and defines the upstream end of the apparatus. An example of a sheet feeder capable of use in the apparatus is illustrated in U.S. Patent No. 5,338,019, the disclosure of which is incorporated herein by this express reference. A stack of box blanks 26 are loaded in the feeder and fed serially by the feeder to the apparatus. A conveyor 28 extends between the sheet feeder assembly and the scoring assembly 16 for conveying blanks through the two printing assemblies 12, 14 and directing the blanks into the scoring and slotting assemblies. A pair of feed rollers 30, 32 are positioned between the sheet feeder assembly and the conveyor for guiding movement of blanks to the conveyor, and an additional upper feed roller 34 is provided at

the upstream end of the conveyor for holding the blanks against the conveyor as the blanks are fed from the stack. Another upper feed roller 36 is provided at the downstream end of the conveyor for guiding blanks into the scoring assembly 16.

5                   The conveyor 28 is supported by a pair of end rollers 38, 40 that are driven to move the conveyor during operation of the apparatus so that box blanks are conveyed on an upper run of the conveyor at a predetermined rate through the printing assemblies and into the scoring and slotting assemblies. The conveyor is formed of a perforated material, and a plurality of vacuum trays  
10                   42 extend beneath and support the upper run of the conveyor. The vacuum trays each include a perforated upper support surface and are connected to a suitable source of negative pressure so that during operation, the blanks are drawn to and held against the upper run of the conveyor as they travel through the apparatus.

15                   The printing assemblies 12, 14 are each adapted to print a single color on the blanks during operation but otherwise are identical to one another. Thus, the number of printing assemblies provided on the apparatus determines the maximum number of colors in which printing can be carried out. Each printing assembly includes a printing cylinder 44, an inking assembly 46 for  
20                   inking the printing cylinder, and an impression cylinder 48 for establishing contact between the box blanks and the printing cylinder as the blanks are conveyed between the cylinders so that an impression is made on the blanks. The printing cylinder 44 is rotatable about a central longitudinal axis that extends in a direction transverse to the travel path defined by the conveyor,  
25                   and includes a fixed circumference on which a printing plate 50 is supported.

                  The impression cylinder 48 of each printing assembly 12, 14 is supported between the upper and lower runs of the conveyor 28 for rotation about an axis extending in a direction parallel to the longitudinal axis of the associated printing cylinder. As illustrated in Fig. 5, an interrupting means is  
30                   provided for moving the printing cylinder 44 and impression cylinder 48 toward and away from one another in a direction transverse to the travel path between a printing position in which the impression cylinder and conveyor bring sheets passing between the cylinders 44, 48 into contact with the printing cylinder and an interrupted position in which the impression cylinder and conveyor are  
35                   spaced from the printing cylinder by a distance sufficient to allow sheets



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passing between the cylinders to remain out of contact with the printing cylinder.

Preferably, the interrupting means includes a pair of eccentric hubs 52 within which the ends of the impression cylinder are supported, and a means for rotating the hubs to shift the impression cylinder toward and away from the printing cylinder in a direction transverse to the travel path defined by the conveyor. Each hub 52 is elongated, presenting opposed inner and outer axial ends. In addition, a number of longitudinally-spaced stepped regions 54, 56, 58, 60 are formed on the outer surface of the hub between the axial ends. The stepped region 54 adjacent the outer axial end of the hub includes a toothed circumference defining a gear by which the hub is rotated. The stepped region 56 adjacent the gear presents a cylindrical outer support surface having a diameter smaller than the root diameter of the gear. The support surface 56 is received in a bore formed in one of the side walls 20, 22 of the frame so that the hub is rotatable, and the gear 54 and the support surface 56 are concentric so that rotation of the gear is guided by the support surface.

The stepped region 60 adjacent the inner axial end of the hub is of a diameter smaller than the other stepped regions, and includes a cylindrical outer circumferential surface defining a central longitudinal axis that is off-set from the longitudinal axis defined by the gear 54 and support surface 56. The vacuum trays 42 adjacent the impression cylinder 48 each include laterally spaced, longitudinally extending arms 62, and each arm extends over and is supported on top of the inner stepped region of one of the hubs so that when the hubs are rotated, the ends of the vacuum trays adjacent the printing assembly are shifted upward and downward relative to the printing cylinder, raising and lowering the conveyor at the same time. The region 58 adjacent to the inner stepped region 60 defines a shoulder for maintaining the spacing between the vacuum trays 42 and the side walls of the frame.

A longitudinally extending bore is provided in each hub, and presents two stepped regions 64, 66. Both regions are cylindrical in shape and concentric with one another, presenting a longitudinal axis that is off-set from the longitudinal axis defined by the gear 54 and support surface 56. The outer stepped region 64 of the bore is a large diameter region within which a bearing assembly 68 is received. The inner stepped region 66 of the bore is a small diameter region within which an axial end of the impression cylinder is received.

The ends of the cylinder are supported within the bearing assemblies 68 to enable rotation of the impression cylinder about the axis of the bore. In addition, this construction enables the impression cylinder to be shifted toward and away from the printing cylinder when the hubs are rotated.

5           A transfer shaft 70 is supported on the frame beneath the impression cylinder for rotation about an axis extending in a direction parallel to the axis of the impression cylinder. The ends of the transfer shaft protrude beyond the side walls of the frame and a pair of gears 72 are fixed to the shaft at positions in alignment with the hub gears 54. Thus, rotation of the transfer  
10       shaft is transmitted to both hubs so that the impression cylinder is moved toward and away from the printing cylinder without upsetting the parallel relationship between the impression and printing cylinders. A belt support roller 74 is mounted for rotation on the transfer shaft at a position between the side walls of the frame, and the lower run of the conveyor 28 is supported by the  
15       roller. Preferably, bearing assemblies are provided on the transfer shaft for permitting this relative rotation of the support roller.

          A pneumatic piston-and-cylinder actuator 76 is supported on the side wall of the frame by a pin and may be pivoted about the pin to accommodate extension and retraction of a piston forming a part of the actuator. A  
20       rotatable sprocket 80 is supported on the frame by a shaft that extends between the side wall of the frame and a bracket 82 that is secured to the frame. The piston includes a distal end that is connected to the sprocket by a pin that permits relative pivotal movement between the piston and the sprocket. A second sprocket 84 is fixed to the transfer shaft 70 immediately above the  
25       lower sprocket, and a chain 86 is received on the sprockets 80, 84 for transmitting rotation of the lower sprocket to the upper sprocket. When the piston is extended from the position shown in solid lines in Fig. 4 to the position shown in dashed lines, the sprocket 80 is rotated in a counterclockwise direction. This rotation is transmitted to the transfer shaft 70 and through the  
30       gears 72 to the hubs 52, rotating the hubs in a clockwise direction from the interrupted position shown in Figs. 2, 4 and 5 to the printing position shown in Fig. 3. Because the impression cylinder 48 is supported on an axis eccentric from the axis about which the hubs rotate, the impression cylinder is shifted upward toward the printing cylinder 44. Likewise the ends of the vacuum trays  
35       42 supported by the hubs are lifted into proximity with the printing cylinder raising the conveyor 28 to the printing position.

As shown in Fig. 5, an electric brake 88 is received on the transfer shaft at a position adjacent to the upper sprocket 84, and is supported on the side wall 20 of the frame. The brake is of conventional construction, and is actuated once the impression cylinder and conveyor have been lifted to the printing position in order to hold them in place. Likewise, the brake is disengaged prior to lowering the impression cylinder to the interrupted position.

A conventional drive means is provided on the apparatus for continuously driving the printing cylinder and inking assembly rollers of each printing assembly, regardless of the position of the impression cylinder relative to the printing cylinder. Preferably, a single drive shaft extends along the frame of the apparatus for driving all of the printing assemblies, as well as the scoring and slotting assemblies and the conveyor.

As shown in Fig. 1, the scoring assembly 16 is conventional, and includes one or more upper scoring wheels 90 supported for rotation on a drive shaft, and a lower anvil roller opposing the scoring wheels. Each scoring wheel includes a means for forming a crease in a blank as the blank is conveyed into the nip defined between the scoring wheel and the anvil roller to define a fold about which the blank can be folded to form a box.

The slotting assembly can either take the form of one of the slotting mechanisms illustrated in U.S. Patent Nos. 5,297,462 and 5,327,804, or can be constructed in accordance with the preferred embodiment illustrated in Figs. 6-8 of the present application. Regardless of the embodiment employed, the slotting assembly generally includes a slotting wheel mechanism for forming slots in the blanks, and an interrupting means for interrupting slotting on the fly during passage of each blank through the slotting assembly to enable a single series of slots to be made in each blank as the blanks are conveyed through the assembly, even when the blanks are of a length greater than the circumference of the slotter wheel mechanism used in the assembly.

Turning to Fig. 8, the preferred embodiment of the slotting assembly includes a plurality of slotting wheel mechanisms 91 spaced laterally from one another along a drive shaft 98. With reference to Fig. 7, each mechanism includes a rotatable drive assembly 92, a rotatable blade wheel 94, a slotter blade 96 coupled with the blade wheel, and support structure for supporting the blade wheel so that it rotates about the same axis as the drive assembly. The rotatable drive assembly broadly includes the drive shaft 98, a

drive motor for rotating the shaft, a hub 99, and a drive wheel 100 secured to the hub. As illustrated in Fig. 6, the drive shaft includes a longitudinal keyway which permits the hub and drive wheel to be secured for rotation with the drive shaft.

5           The rotatable blade wheel 94 is provided for carrying the slotter blade 96 for making slots in the box blanks as they are fed through the assembly. The blade wheel is positioned adjacent the drive wheel 100 along the drive shaft 98 and is rotatable about the shaft. The support structure supports the blade wheel and slotter blade for rotation about the drive shaft and  
10 includes a circumferential track 102 and a plurality of blade wheel rollers 104. The track is supported on a stepped end section formed in the rear end face of the hub 99. The track rotates with the hub and is secured thereto by a plurality of screws. The track 102 is concentric with the drive shaft and presents an outer circumferential, inverted V-shaped track surface for engaging  
15 the blade wheel rollers 104.

The blade wheel rollers are rotatably coupled with the blade wheel by suitable fasteners that allow rotation of the blade wheel rollers. Each roller includes an outer circumferential groove shaped for receiving the V-shaped track surface of the circular track 102. Thus, the blade wheel rollers  
20 support the blade wheel for rotation about the drive wheel shaft.

The slotting assembly 18 also includes blade rotating structure for selectively rotating the slotter blade 96 relative to the drive wheel independently of the drive shaft.

In more detail, the blade rotating structure broadly includes a  
25 servo motor 106 and a gear assembly 108. The servo motor is coupled with a suitable source of electric power, and includes an output shaft 110. The gear assembly includes a support yoke 112, a drive pulley 114 and two idler pulleys 116. The support yoke is a metallic support member including a vertically extending leg section and two depending leg sections. The drive pulley is  
30 rotatably supported on the vertically extending leg of the yoke and is rotatably coupled with the servo motor output shaft. The idler pulleys are rotatably mounted on the depending leg sections of the yoke. A cogged belt 118 is positioned over the drive and idler pulleys and movement of the belt is driven by the servo motor. The cogged belt engages teeth formed along the  
35 circumference of the blade wheel. The blade rotating structure also includes a controller 120 for controlling the rotational speed of the servo motor.

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In operation, the components of the blade rotating structure cooperate for rotating the slotter blade independently of the drive assembly. The rotational speed of the slotter blade 96 can be selectively adjusted relative to the rotational speed of the drive wheel so that the slotting blade can be placed in either a cutting position or an idle, non-cutting position. For example, the controller 120 and servo motor 106 can initially rotate the blade wheel 94 at the same rotational speed as the drive wheel 100 so that the slotter blade makes slots or cuts during every rotation of the drive wheel. Then, the controller and servo motor can stop the rotation of the blade wheel to allow the rotatable drive assembly to continue to advance a box blank without further slotting.

In the preferred embodiment of the apparatus, the controller 120 controls interruption of the printing assemblies and the slotting assembly to enable printing and slotting of universally sized box blanks. A sensing element 122 is provided along the conveyor for sensing the presence of each box blank as it is fed from the stack and for monitoring the progress of each blank through the apparatus. Preferably, this sensing element is an optical sensor or the like that is positioned at or near the upstream end of the conveyor. The optical sensing element detects the presence of each blank as it passes the element, and the controller 120 includes a means for tracking progress of the blank through the apparatus based upon the driven speed of the conveyor 28.

The controller 120 includes an input means for allowing an operator to input information relating to the length of the box blanks to be handled in any particular printing/slotting operation. In response to this inputted information, the controller actuates the piston-and-cylinder actuators 76 of the printing assemblies and the servo motor 106 of the slotting assembly in order to carry out printing and slotting only at the designated positions of each blank, and to interrupt printing and slotting along the remainder of the length of each blank, even when the length of the blanks is several times greater than the circumference of the printing cylinders or blade wheel. Thus, it is possible to combine control of the printing assembly and of a suitable slotter wheel mechanism to permit printing and slotting of such universally sized blanks in a single apparatus.

Although the present invention has been described with reference to the preferred embodiment, it is noted that equivalents may be employed and

substitution made herein without departing from the scope of the invention as recited in the claims.

What is Claimed Is:

1. A box blank forming apparatus for use in forming box blanks of variable length, the apparatus comprising:

a frame;

a printing cylinder having a central longitudinal axis and being supported on the frame for rotation about the longitudinal axis;

a drive means for driving rotation of the printing cylinder;

an impression cylinder supported on the frame for rotation about an axis parallel to the longitudinal axis of the printing cylinder;

a feeding means for feeding the sheets along a travel path extending between the printing cylinder and the impression cylinder;

an interrupting means for moving the printing cylinder and impression cylinder toward and away from one another in a direction transverse to the travel path between a printing position in which the impression cylinder brings sheets passing between the cylinders into contact with the printing cylinder and an interrupted position in which the impression cylinder is spaced from the printing cylinder by a distance sufficient to allow sheets passing between the cylinders to remain out of contact with the printing cylinder;

a control means for actuating the interrupting means to move the printing and impression cylinders relative to one another between the printing and interrupted positions during rotation of the printing cylinder and operation of the feeding means to enable a single impression to be made on each sheet as the sheets are passed between the cylinders, regardless of the length of the sheets.

2. A box blank forming apparatus as recited in claim 1, wherein the impression cylinder includes a pair of opposed axial ends, and the interrupting means includes a pair of eccentric hubs within which the axial ends of the impression cylinder are supported for rotation, the interrupting means further including a means for rotating the hubs to shift the impression cylinder toward and away from the printing cylinder between the printing and interrupted positions.

3. A box blank forming apparatus as recited in claim 2, wherein the means for rotating the hubs includes a fluid-operated piston-and-cylinder actuator and a transmission means for rotating the eccentric hubs in response to movement of the actuator.

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4. A box blank forming apparatus as recited in claim 2, wherein the interrupting means includes a brake for braking rotation of the hubs at the printing and interrupted positions.

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5. A box blank forming apparatus as recited in claim 2, wherein the feeding means includes a conveyor having an upper run extending along the travel path and between the printing and impression cylinders, and a lower run extending beneath the travel path and the printing and impression cylinders.

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6. A box blank forming apparatus as recited in claim 5, wherein the conveyor is perforated and the feeding means includes a means for drawing a vacuum through the conveyor during operation of the apparatus to draw the sheets to the conveyor as the sheets are conveyed along the travel path.

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7. A box blank forming apparatus as recited in claim 6, wherein the means for drawing a vacuum through the conveyor includes a vacuum bed supporting the upper run of the conveyor along the travel path on each side of the impression cylinder, the vacuum beds each including a first end that is remote from the impression cylinder and supported on the frame for pivotal movement about an axis extending in a direction parallel to the longitudinal axis of the printing cylinder, and a second end that is supported on the eccentric hubs so that when the impression cylinder is shifted to the printing position, the conveyor and impression cylinder bring sheets passing between the cylinders into contact with the printing cylinder, and when the impression cylinder is shifted to the interrupted position, the conveyor and impression cylinder are both spaced from the printing cylinder by a distance sufficient to convey sheets between the cylinders out of contact with the printing cylinder.

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8. A box blank forming apparatus as recited in claim 1, wherein the control means actuates the interrupting means to move the impression cylinder to the printing position during substantially one revolution of the printing cylinder as each sheet is fed between the cylinders, and actuates the interrupting means to move the impression cylinder to the interrupted position as any remainder of each sheet is fed between the cylinders so that sheets of a length greater than the circumference of the printing cylinder are only printed on once as they are fed between the cylinders.

9. A box blank printer/slotter apparatus for making box blanks from sheets of variable length, the apparatus comprising:

a printing means for printing on the sheets, the printing means including a rotatable printing cylinder;

a slotter means for forming slots in the sheets, the slotter means including a rotatable blade;

a feeding means for feeding the sheets along a travel path extending through the printing and slotting means and for bringing the sheets into contact with the printing cylinder and the slotter blade;

a first interrupting means for removing the sheets from contact with the printing cylinder;

a second interrupting means for removing the sheets from contact with the slotting blade; and

a control means for controlling operation of both the first and second interrupting means, the control means actuating the first interrupting means to bring each sheet into contact with the printing cylinder only while a single impression is made on the sheet, and to remove each sheet from contact with the printing cylinder before and after the single impression is made,

the control means actuating the second interrupting means to bring each sheet into contact with the slotting blade only while a single slotting operation is carried out by the slotting means, and to remove each sheet from contact with the slotting blade before and after the single slotting operation is made.

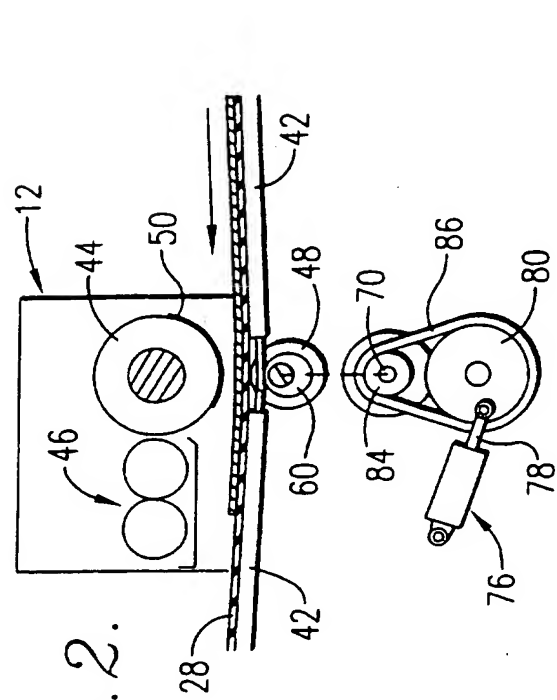


FIG. 1.

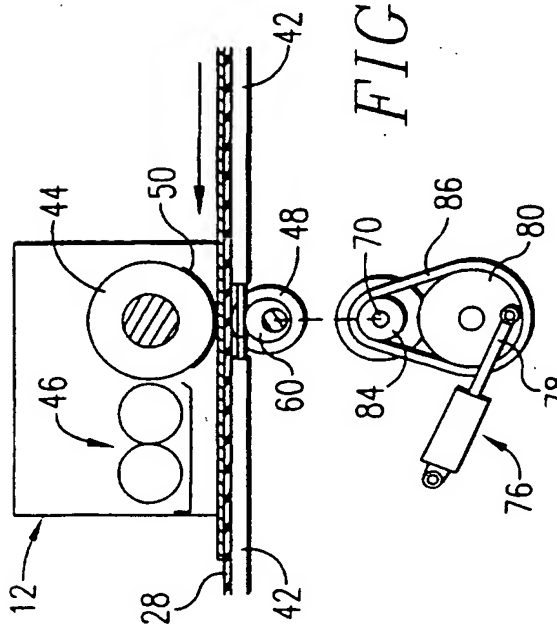


FIG. 2.

FIG. 3.

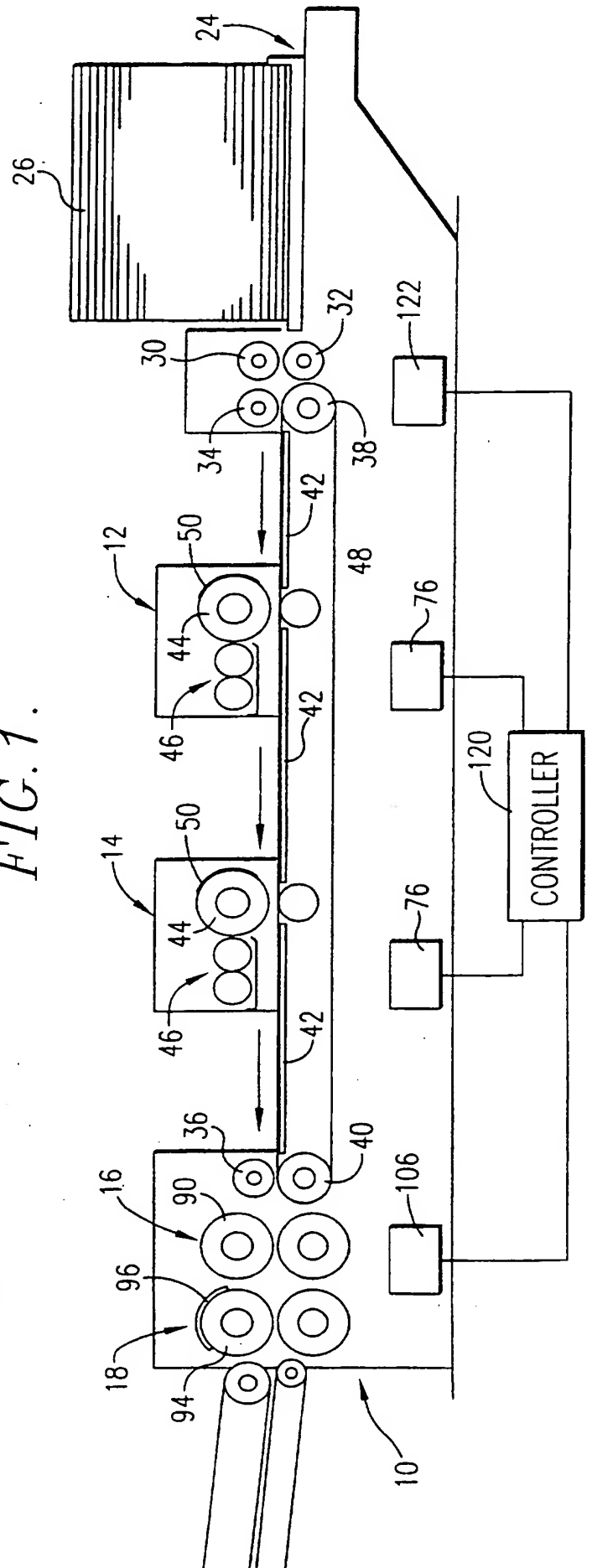


FIG. 4.

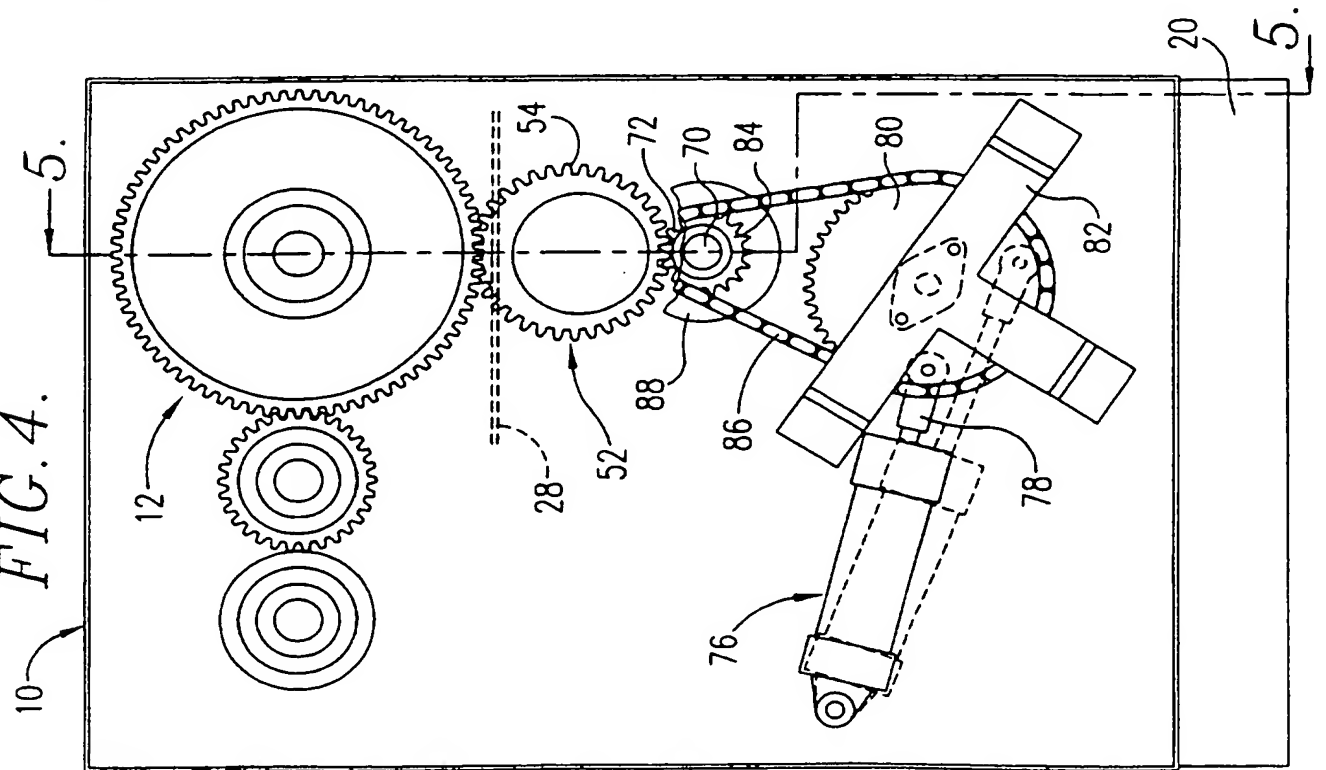
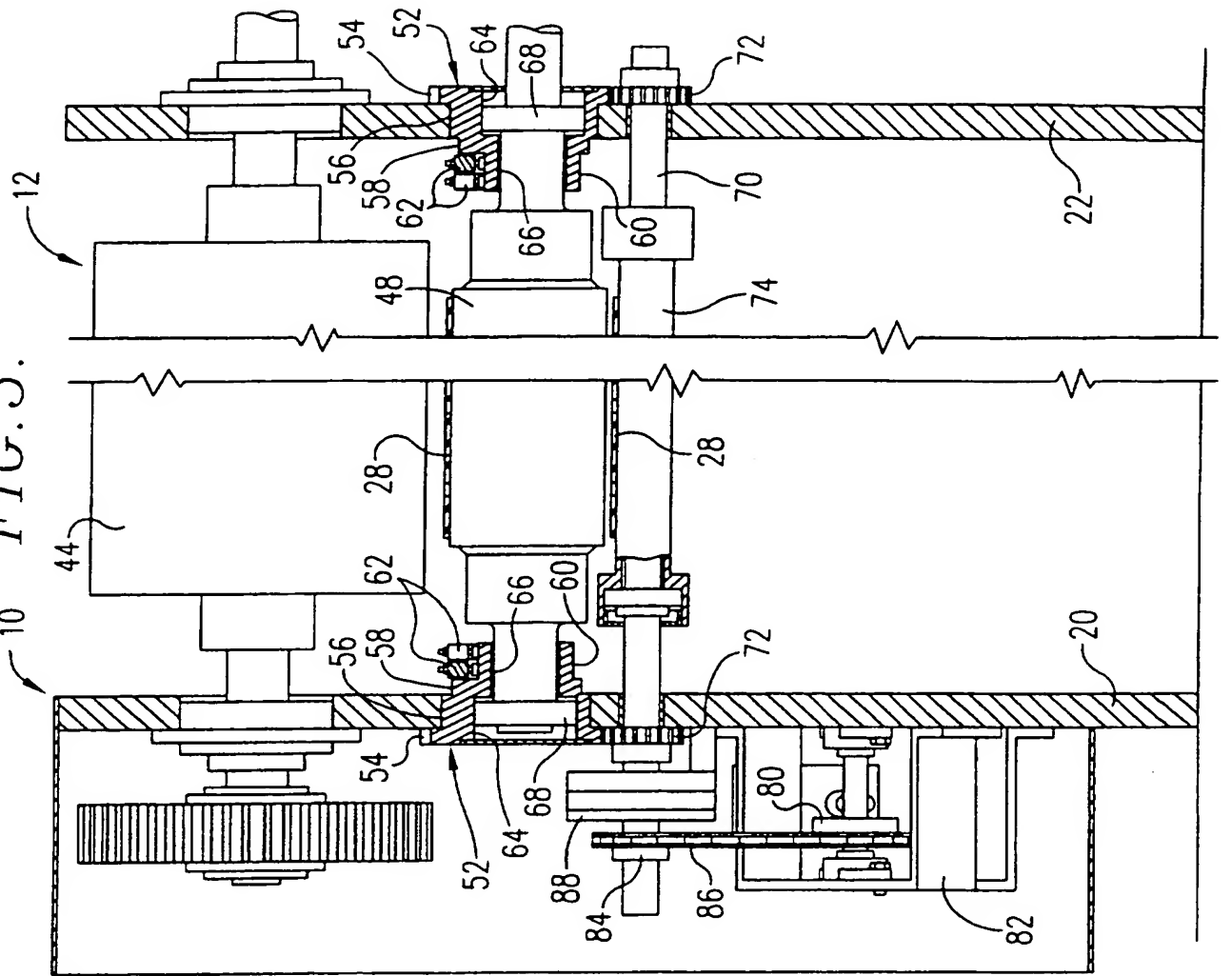
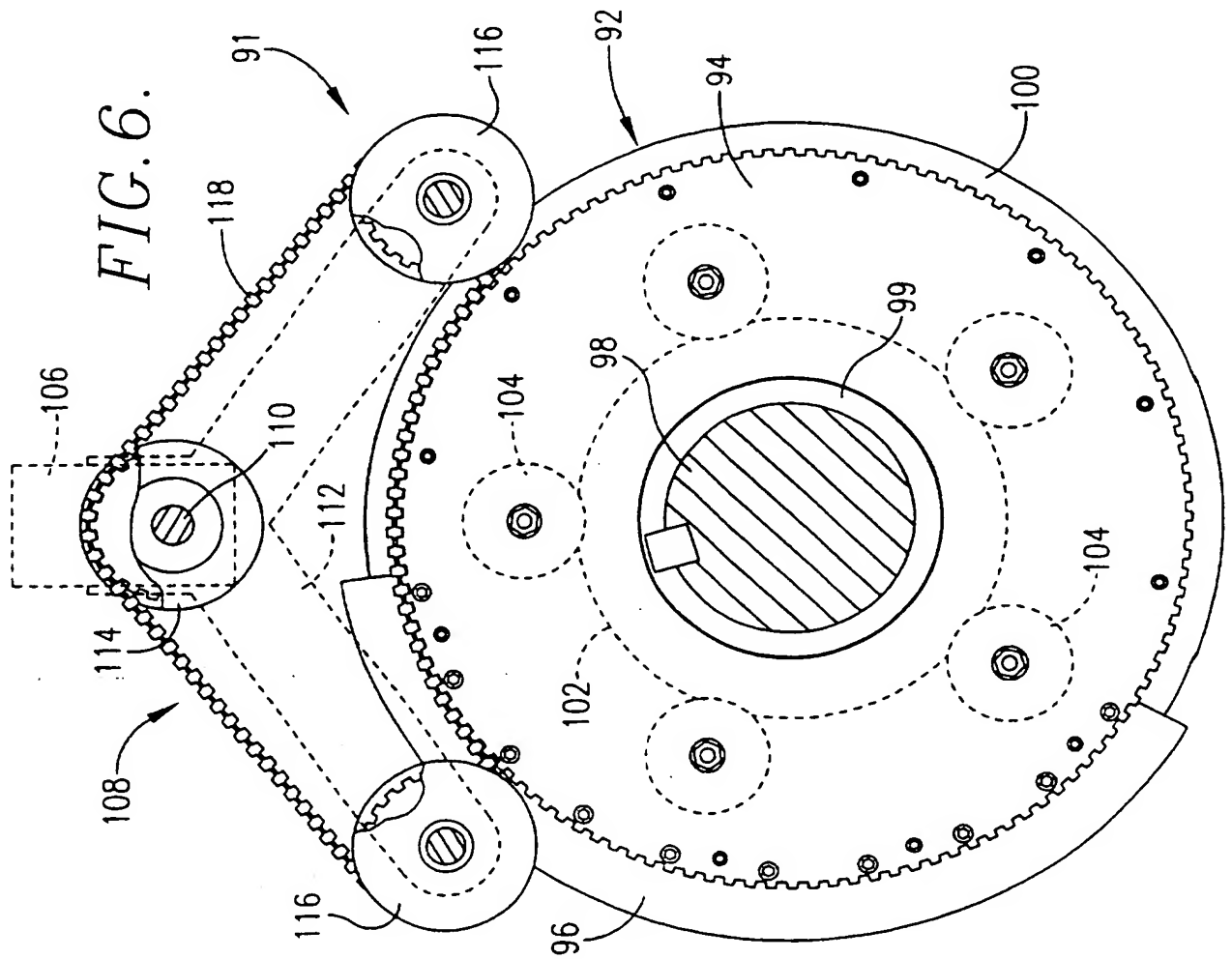
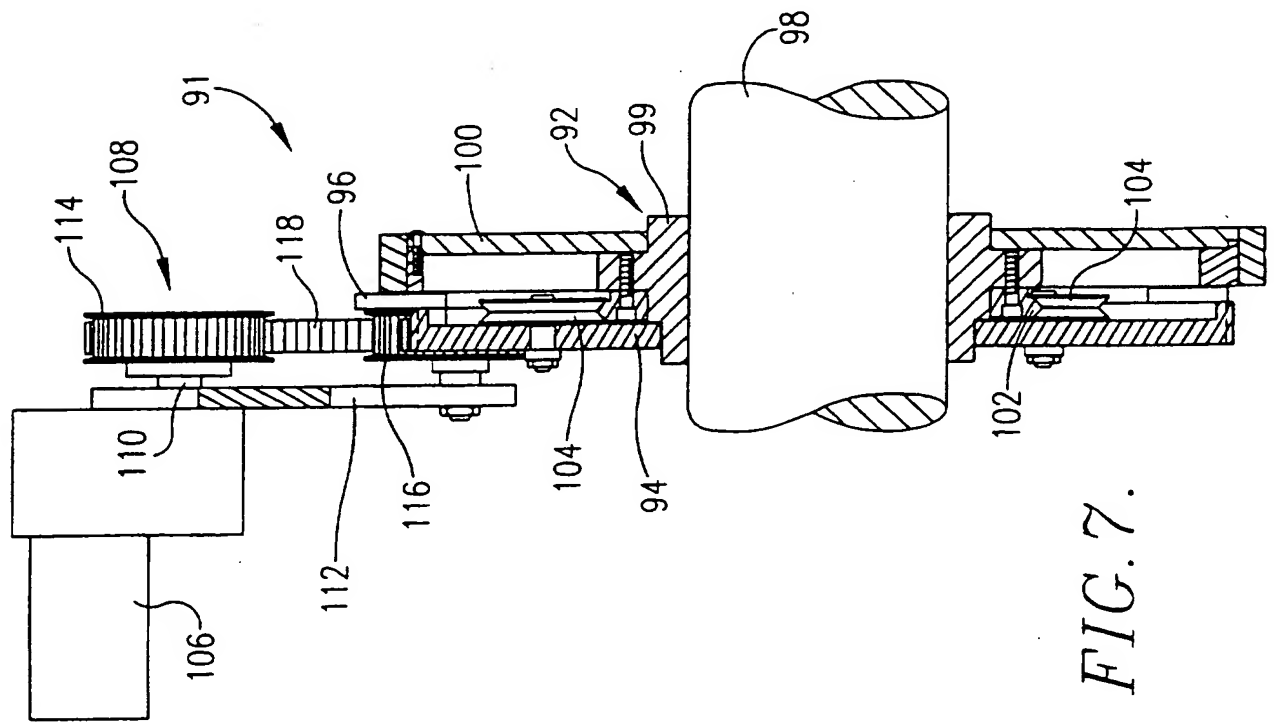


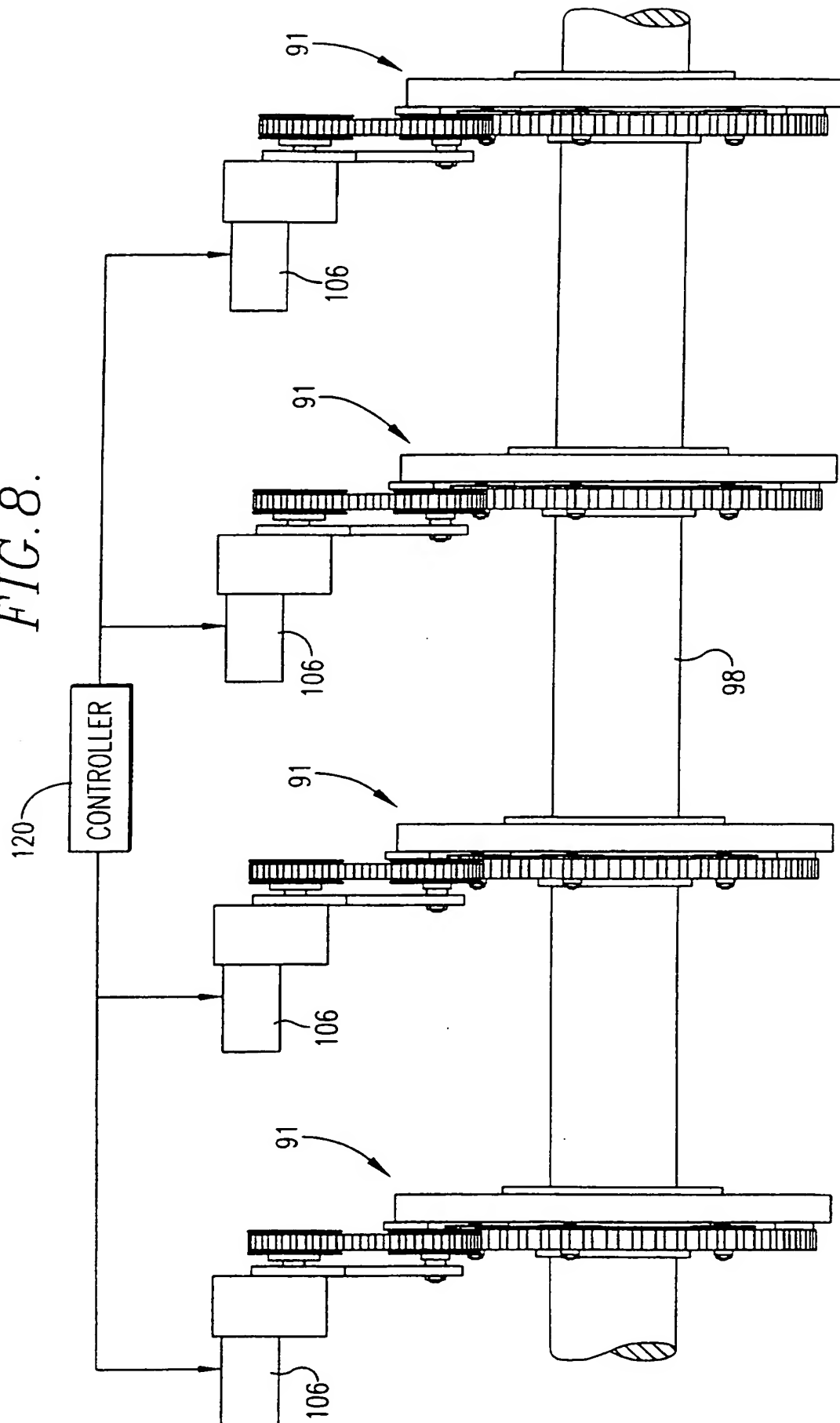
FIG. 5.





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FIG. 8.



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US96/15324

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :B31B 1/14, 49/02, 1/88; B41F 11/00, 13/24, 15/04

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,604,083 A (BARNY ET AL.) 05 AUGUST 1986, See entire specification.	1-6, 8
Y	US 4,108,067 A (WERNER) 22 AUGUST 1978, See entire specification.	1-6, 8, 9
Y	US 4,458,591 A (GUARALDI) 10 JULY 1984, See entire specification.	2-6
Y	US 3,769,910 A (HEIMLICHER ET AL.) 06 NOVEMBER 1973, See entire specification.	3, 4
Y	US 3,611,884 A (HOTTENDORF) 12 OCTOBER 1971, See entire specification.	6
Y	US 5,327,804 A (CREADEN) 12 JULY 1994, See entire specification.	9

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	Y	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	G	document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means		
*P* document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 23 OCTOBER 1996	Date of mailing of the international search report 06 NOV 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DARREN ARK Telephone No. (703) 308-1148

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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/15324

## A. CLASSIFICATION OF SUBJECT MATTER:

US CL :

493/8, 22, 25, 34, 53-55, 59, 64, 320, 321, 323, 324, 363, 365, 367, 369, 370; 83/304, 332, 564, 678; 101/115, 182-185, 247

## B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

493/8, 22, 24, 25, 34, 53-55, 59, 64, 187, 188, 227, 228, 240, 241, 270, 320, 321, 323, 324, 355, 363, 365, 367, 369, 370; 83/304, 322, 332, 564, 678; 101/115, 182-185, 226, 227, 247

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